*Ann R Coll Surg Engl* 1996; **78**: 544–552

## SURGICAL HISTORY

# The history and evolution of surgical instruments

## VII Spring forceps (tweezers), hooks and simple retractors

**John Kirkup** MD FRCS
*Honorary Curator, Historical Instrument Collection*
The Royal College of Surgeons of England, London

**Key words:** Surgical instruments; History; Spring forceps; Hooks; Retractors

**Instruments manufactured by bending a basic metal strip or rod, either about its middle to create spring forceps (tweezers), or towards one extremity to create hooks and retractors are related structures. Spring forceps depend on tension mediated at the bend (hoop) or fixed end which is transmitted as dynamic 'spring' to the jaws, whereas the bend of hooks and retractors remains fixed and static. If such instruments refine the digital postures of pinch, pincer and retraction during surgery, they have not supplanted these manual actions entirely.**

**After a brief historical introduction, the structure, modifications, functions and controls of spring forceps are analysed. Importantly, this instrument enjoys both right and left-handed functions, some of which are ancient, some transient as haemostats and needle-holders, and some, including left-handed dissection, surprisingly recent.**

**Hooks are sharp or blunt and, among other functions, pre-date the left-handed spring forceps for dissection; in general hooks function as retractors. Hand-held retractors are enlarged blunt hooks, the wide retracting contact surface reducing trauma to wound margins and viscera. The physical effort of employing these retractors deep in body cavities is abated by applying them autostatically around a square or circular frame.**

... well-made dissecting forceps may be useful, and the more so if the operator has not had experience in the matter, and cannot readily and cleverly use the nails and joints of his fingers.

*On Surgical Dissection,* Liston, 1837 *(1)*

Correspondence to: Mr J Kirkup, Weston Hill, 1 Weston Park East, Bath BA1 2XA

As Darwin observed, monkeys use their hands to "pull out thorns and burs, and hunt for each other's parasites ... nevertheless they are clumsy in these various actions," compared to man *(2)*. Nonetheless, these 'foreign body' extractions emphasise a long evolution of tweezer-like opposition between thumb and fingers, a posture familiar to many anxious to remove a wooden splinter or a thorn embedded in their hands or feet. Closer analysis of human thumb and index finger opposition displays two functional positions, as suggested by Møller-Christensen *(3)*. First, a meeting of pulp surfaces with the digits aligned almost tangentially, the pulp-pinch grip (Fig. 1*A,B*) and, second, a meeting of nail margins with distal extremities of digits end-on, the nail-pincer grip (Fig. 1*C,D*). For the latter, the nail margins of thumb and index finger meet obliquely and, despite more power, this may be less precise than the thumb and ring finger extraction grip when nail margins meet in parallel *(4)*. The pulp-pinch grip resembles a spring forceps without teeth and the nail-pincer grip a spring forceps with teeth. A third functional position arises when thumb pulp opposes index finger nail, as in removing loose milk teeth, an activity familiar to many parents; however, the equivalent dental extraction forceps is not a spring forceps. It is suggested the original 'forceps' were blacksmith's tongs for forging metal (Latin, *formus*, hot or *ferrum*, iron, and *capere*, to hold) *(5)*. Today, 'forceps' is applied loosely, to any surgical instrument which fixes or grips tissues or structures, embracing a definition which includes tweezers, dissecting forceps, intestinal clamps, artery forceps, dental forceps, bone cutting forceps, obstetric extraction forceps and so on. In general, forceps have two limbs, either rivetted together at one end to create a spring forceps or crossing and hinging to create a pivot forceps; exceptionally, surgical

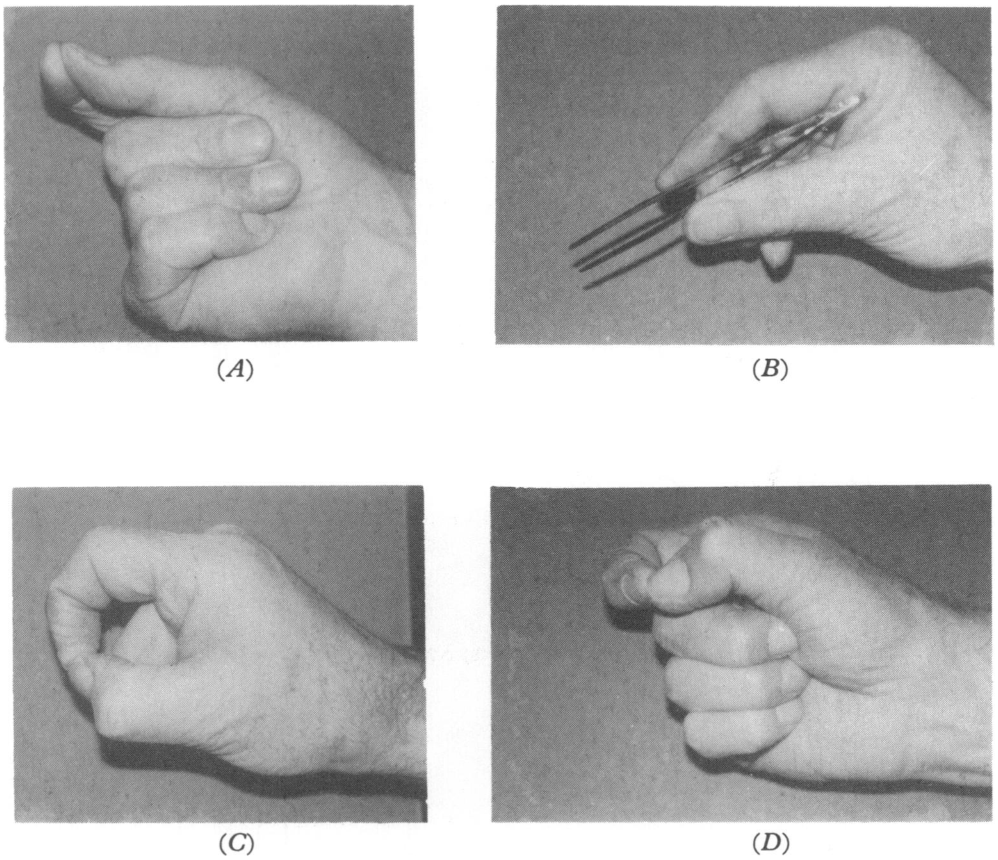

*Figure 1. A,* Pulp-pinch grip. *B,* Spring forceps controlled by pinch posture. *C,D,* Nail-pincer grip showing obliquity of nails.

forceps have three limbs or combine both spring and pivot mechanisms. The sophisticated pivot forceps family demands separate study.

Spring forceps or tweezers (Latin, *vulsella,* a plucking item) are readily formed by bending a metal strip on itself, as in the case of common sugar tongs. It is likely this metallic shape was preceded by organic precursors, possibly certain bivalve shells, pliant green wood bent to shape, or bamboo split and wedged open below a node, the elasticity at the apex or hoop being preserved when dry. Green wood forceps are still made by British rural craftsmen to handle baked potatoes on an open fire *(6).* In late nineteenth century Sarawak, a wooden device of spring forceps construction, controlled by removable loops of cane, was employed to immobilise the glans penis during ritual transfixion with a metal bar (Fig. 2*A*).

In this century, spring forceps were manufactured in one piece, from wood, to handle radium for medical application *(7)* and, latterly, moulded from plastic for immediate disposal after application (Fig. 2*B*).

## Historical background

Møller-Christensen's important treatise, *The History of the Forceps,* published in 1938, considered early developments based on archaeological material in European museums which rarely has medical provenance. He believed certain gold, silver, copper and bronze tweezers for epilation, found in the Middle East *c.* 3000 BC, were capable of removing splinters and thorns, and thus were the forerunners of surgical spring forceps *(8).* His physical analysis of larger copper Egyptian forceps, perhaps as old as 3300 BC, convinced him that many were applied surgically to extract arrow heads and other missiles. On the other hand, he believed the numerous forceps of the second and first millenia BC found in Scandinavia and Northern Europe, were not for surgery but for epilation and shaving *(9).*

In reality, before AD 97 when the ash of Vesuvius buried surgical instruments, since located in physicians' dwellings at Pompeii (Fig. 3*G,H*), medical provenance is uncertain. Even forceps for undoubted surgical procedures, described by Hippocrates, *c.* 400 BC *(10)* and later authors, create doubts of identity between spring and pivot forms. Among 556 Pompeian and other accepted Roman surgical instruments of the first to fifth centuries AD, spring forceps form 12.5% and pivot forceps but 4.5% of the total, a ratio which reversed by the fifteenth century *(11).* Whereas over 80% of Roman instruments scrutinised are made of copper alloy (bronze), usually in good condition, any 'steel' and iron items are corroded severely or are fragmentary. The precipitate disappearance of instrument

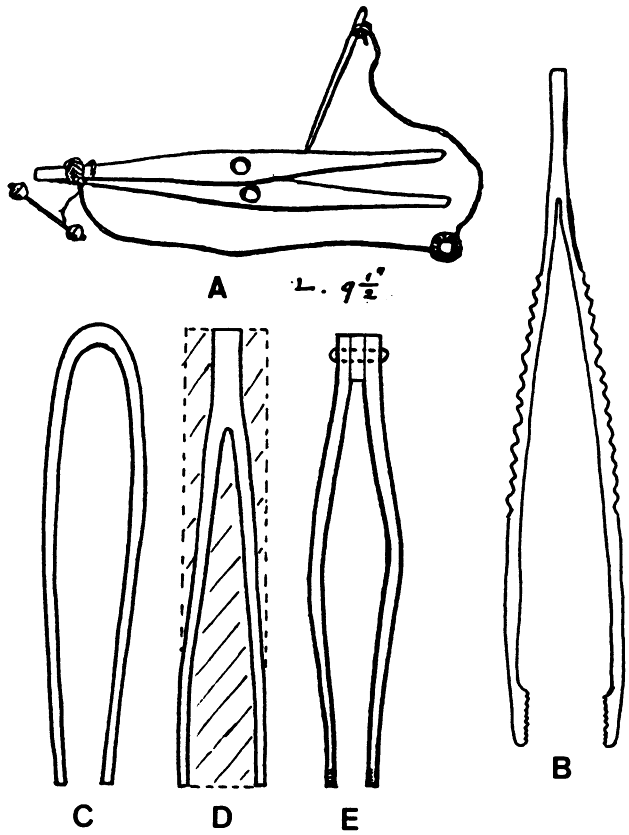


*Figure 2. A,* Device of springy wood, controlled by cane loops to hold glans penis during ritual transfixion of metal bar. Late nineteenth century, Baram River district, Sarawak. (In Museum of Mankind Reserve Collection, London, EAS6996). *B,* Plastic single-piece spring forceps. *C,* Egyptian-type forceps. *D,* Roman forceps cut from bronze block. *E,* Modern-type forceps riveted with intermediate block.

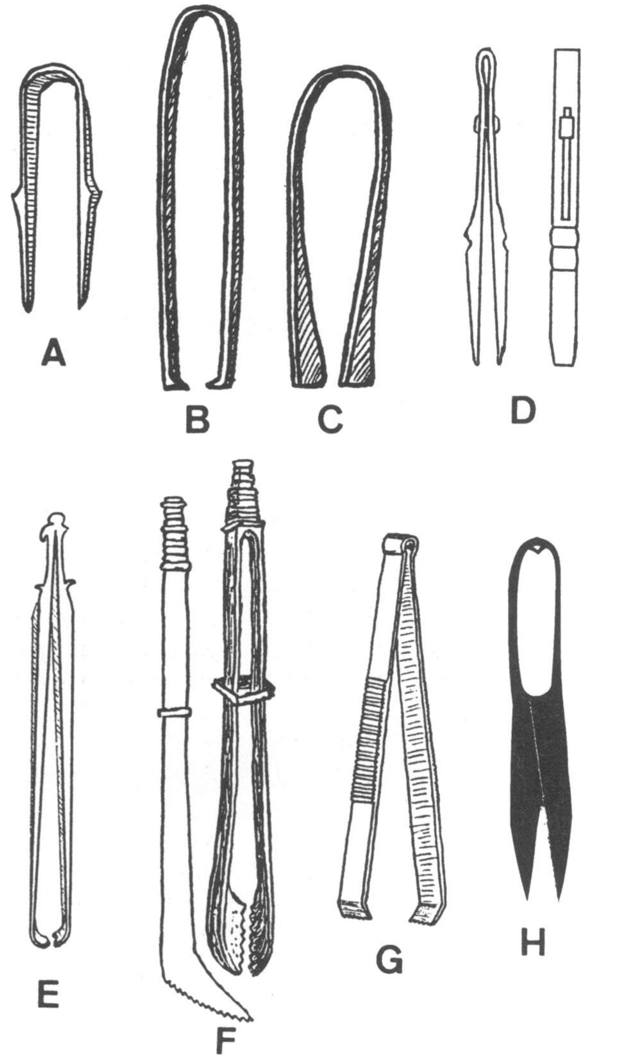


*Figure 3. A,* Copper Egyptian forceps, *c.* 3300 BC. *B,C,* Bronze Egyptian embalming forceps, Roman period. *D,* Bronze Egyptian forceps with 'collar stud' control, Roman period. *E,* Bronze Roman early toothed forceps. *F,* Bronze Roman toothed forceps with slide control, Colchester, UK. *G,* Bronze Roman toothed forceps, Pompeii. *H,* Bronze Roman shears, Pompeii. (Møller Christensen V. *The History of the Forceps,* 1938.)

survivals in the Dark Ages until the sixteenth century remains an enigma which has not been fully explained; perhaps the use of low-grade steel and its ready disintegration is the principal factor? Albucasis, writing *c.* AD 1000, illustrated a largely steel-based surgical armamentarium and, in a manuscript copy of 1465–1466, tweezers with a sliding collar are suggested *(12)* (Fig. 3*F*). Møller-Christensen drew attention to medieval spring forceps excavated from monasteries in Denmark and Sweden believing they were employed surgically *(13)*; all are composed of copper alloy, which poses the question, why similar forceps of this period have not appeared elsewhere?

In the major sixteenth-century treatises of Croce, Ryff, Paré and Guillemeau *(14)* a few small tweezers are illustrated, but survivals are not known.

In seventeenth- and eighteenth-century armamentaria, they form 2–3% of total instrumentation, and survivals are found in museum collections. Adapted to anatomical dissection in the later eighteenth century and to surgical dissection in the nineteenth century, the spring forceps formed some 10% of total instrumentation by the mid-twentieth century; by contrast, pivot forceps augmented steadily to some 50% *(15)*.

## Structure and controls (Table I)

### Basic constructions

Three basic metallic constructions can be identified (Fig. 2*C–E*). The simplest entails folding a strip of metal on itself, almost certainly the earliest form, if we exclude tiny cosmetic tweezers made by splitting one end of a narrow rod. Later, the hoop or fixed end was modified to form a near circle for certain forceps, shears and seton forceps (Fig. 3*G*, Fig. 4*C*). The second involves removing metal from a block, usually of bronze, to leave a spring forceps shape. The third is made from two separate limbs or legs which are welded or riveted together at one end, usually with an intermediate block of the same but sometimes a different metal. All three constructions were known to the Romans and the excavated block method appears to be exclusive to their manufacture. Today most surgical spring forceps are made by the third method. Manufacturers fix the limbs at an acute angle (generally 5°–15°) to separate the jaws as particular function demands; the curvature of the limbs, or its absence, also defines jaw separation; fine finishing usually camouflages evidence of riveting. The 'spring' is determined by elasticity in the limbs which are narrowed in section deliberately at the hoop or fixed end, in contrast to the distal extremities which must be firm and unbending; spring resistance is easily overcome by opposing digits and must recover to the open position on release.

## Unusual structures

These include three-limbed and take-apart spring forceps. An early triple-ended design is associated with Alfonso Ferri who employed it for bullet extraction in 1555 *(16)*; the limbs are welded together proximally and a ring slide controls jaw closure (Fig. 4*A*). Known as the Alphonsinum, it was modified later for gynaecological sponge holding. In the mid-nineteenth century, Bonnefin invented a three-legged forceps to approximate wounds during suturing *(17)*; this was overlooked by Møller-Christensen and others in the twentieth century who claimed their own priority *(18)*.

At the inception of aseptic surgery, it was believed vital to remove all vestiges of blood and other debris from instruments, despite subsequent heat sterilisation. Cleaning the acute angle at the fixed extremity of spring forceps was difficult and the makers Jetter and Scheerer, and Down Brothers, introduced dismounting or take-off joints to facilitate thorough cleansing of the separated limbs *(19)* (Fig. 5*F*). This extra craftsmanship cost money and disjointing versions did not prove popular.

## Jaws

The shape and nature of jaws vary widely and determine particular functions; fine for thorn extraction, broad for craniotomy, C-shaped for ocular specula, deeply grooved or copper infilled for needle-holding, flattened and asymmetrical for eyelid holding, spiked for tongue holding, straight, curved, fenestrated, hooked, etc. Initially smooth, the Romans introduced teeth which improved the grip (Fig. 3*E–G*). The cross-ridging of jaws, characteristic of dissecting forceps, is not clearly seen until the seventeenth century (Fig. 4*B*).

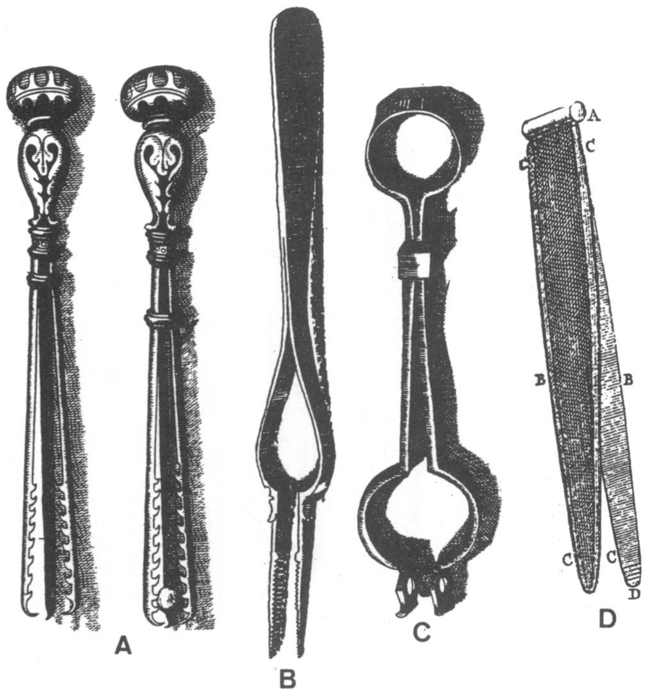


*Figure 4. A,* Steel three-limbed bullet forceps controlled by ring, the 'Alphonsinium'. *B,* Steel 'volsella' with strong transverse teeth for extracting bone fragments. *C,* Steel seton forceps controlled by slide (Scultetus J. *Armamentarium Chirurgicum,* 1655). *D,* Steel dissecting forceps (Garengeot R. *Des Instruments de Chirurgie les Plus Utiles,* 1725.

## Locking devices

The automatic control of jaws by means of transverse collar studs (Fig. 3*D*), sliding rings (Fig. 3*F* and Fig. 4*A,C*), transverse spring catches (Fig. 5*A,B*), external locking slides (Fig. 5*C–F*), transverse screws (Fig. 6*A,B*) and so on improved efficiency, promoting continuous action independent of manual contact. However, the power of closure, especially for haemostasis, was limited and often confined to one position. These instruments were replaced by powerful pivoting forceps with rack closures in the late nineteenth century.

*Table I.* Spring forceps: action, structure and control

| *Action* | *Structure* | *Control* | *Examples* |
|---|---|---|---|
| Dissect and extract | Simple—2 limbs | Opposed digits | Dissecting and splinter forceps |
| Fix and clamp | (a) Simple + closure device | Rings, slides, catches, etc | Artery, tongue and needle holding |
| | (b) Cross acting | Self-closing | Bulldog clamps, towel clips |
| Retract | Simple | Self-opening in narrow apertures | Nasal and ocular specula |
| Triple purchase | Compound—3 limbs | Sliding ring or tube | Bullet catches, sponge holders |
| Motivate | Composite with pivot | Opposed digits | Iris scissors, needle holders |

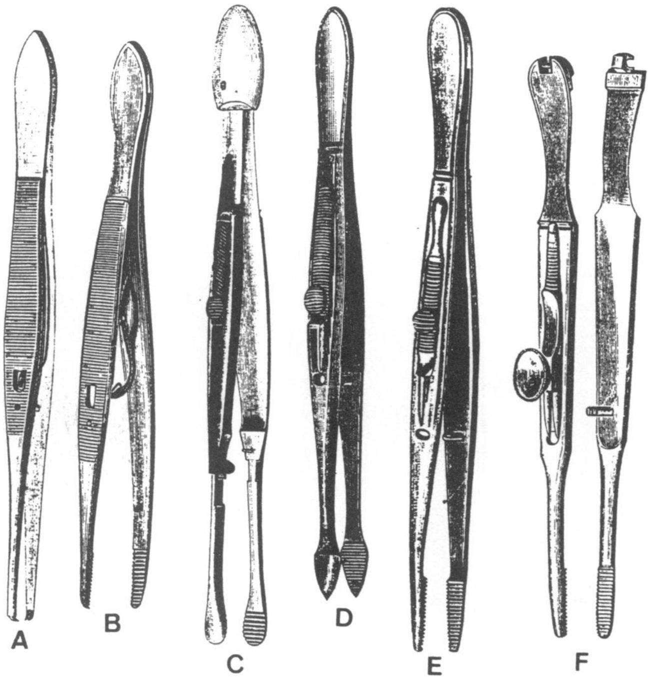


*Figure 5. A,B,* Artery forceps with spring catch, Liston type. *C,* Artery forceps, with slide and ivory 'ball' to control torsion, Bryant's. *D,* Artery and needle-holding forceps with slide, Andrew's. *E,* Artery and needle-holding forceps with slide, Bardelben's. *F,* Artery forceps, disjointing with slide, Schwabe's. (Jetter and Scheerer, *Illustrated Catalogue . . ., c.* 1895.)

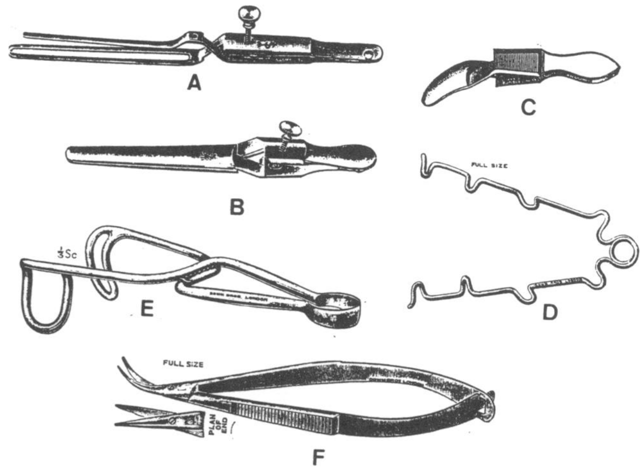


*Figure 6.* Cross-action forceps. *A,* Bowel clamp with transverse screw control, Meissenbach's. *B,* Bowel clamp with transverse screw control, Makin's (Jetter & Scheerer, *Illustrated Catalogue . . ., c.* 1895). *C,* Bulldog artery clamp, Dieffenbach's (Krohne & Sesemann, *A Catalogue of Instruments,* 1879). *D,* Eyelid retractor, Bowman's. *E,* Abdominal retractor, Dartigue's. *F,* Iris scissors with screw pivot and disjointing spring hoop, Castroviejo's (Down Bros. *Surgical Instruments . . .,* 1952).

### Cross action

This notable advance was introduced by the instrument maker Charrière before 1837 *(20)*; he crossed the limbs to convert the opening force of the 'spring' into a closure or compression mechanism (Fig. 6), eg bulldog clamp, eyelid retractor, intestinal clamp, abdominal retractor, towel clip, penile clamp, etc. Certain three-limbed tracheal and vascular forceps also operate by cross action, the third limb functioning via a pivot joint *(21)*.

### Shears action

Shears, structural relatives of spring forceps, are manufactured to maintain sliding opposition of the flat sharpened jaws during shearing or scission (Fig. 3*H*); apart from scanty classical accounts *(22)*, evidence of their employment in surgery is uncertain.

## Right- and left-handed functions (Table II)

Modern anatomists and surgeons automatically apply dissecting forceps in the left hand; such specific control, however, was a late development in the forceps' slow evolution. In this communication, the right hand is considered dominant.

The cosmetic plucking of hair and thorn extraction with tweezers, from early historic times, required the precision of the right hand; wound dressing forceps were applied similarly. Conversely, the necessity to fix hair for shaving (Fig. 3*F*) or a tumour for excision demanded the left hand, in order to free the dominant hand for exact control of razor or scalpel. In medieval times, the Alphonsinium (Fig. 4*A*) was held in the right hand, providing maximum delicacy of touch and mobility. And in the seventeenth century, the spring seton forceps of Scultetus was applied left-handed, to facilitate passage of needle and silk in the right hand through apertures in its jaws clamped on skin and subcutaneous tissues *(23)* (Fig. 4*C*).

In the early eighteenth century, anatomists began to employ spring forceps in the left hand for detailed fine dissection (Fig. 4*D*), although they continued to use hooks or their left thumb and index finger for grosser dissection. By the late eighteenth century, anatomical dissection forceps were employed more widely and contributed to post-mortem work *(24,25)*. Finally, in the 1830s, dissecting forceps entered the operating theatre *(26,27)* and gradually replaced left-handed hooks and digits. During the nineteenth century, spring forceps enjoyed a considerable revival, being modified as artery forceps and needle-holders (Fig. 5*C–F*); for maximum precision, they were applied in the right hand.

The use of fixation forceps in the left hand for shaving disappeared many centuries ago, as has application of the seton and bullet forceps. Within a century of introduction, both artery and needle-holding spring forceps vanished to be replaced by more powerful pivot forceps and other instruments. However, the right hand continues to manipulate tweezers for foreign body extraction, standard spring forceps for dressing purposes, cross-action clamps and clips, endoscopic grasping forceps and certain pivoting iris scissors and needle-holders which incorporate spring forceps control (Fig. 6*F*)

*Table II.* Spring forceps: right- and left-handed functions

| *Historical period* | *Right hand* | *Left hand* |
|---|---|---|
| Pre-Roman | Depilation<br>Foreign-body extraction | [Holding hair for shaving] |
| Roman | Wound dressing | Tumour fixation |
| Renaissance | [Bullet extraction] | [Seton formation] |
| Eighteenth century | — | Anatomical dissection |
| Nineteenth century | [Haemostasis]<br>[Needle-holding] | Surgical dissection |
| Twentieth century | Endoscopic manipulation | — |

NB—Items within brackets: obsolete functions

### Dissection forceps

The flowering of accurate anatomical dissection precipitated by Vesalius was conducted with a specialised armamentarium which lacked spring forceps; dissection was achieved by left-handed digital pinch and pincer grips, a variety of hooks and retracting ligatures sutured to skin margins *(28)*. These accessories predominated until well into the nineteenth century.

Meanwhile in 1723 Garengeot discussed, illustrated (Fig. 4*D*) and named the dissecting forceps, perhaps for the first time, although his account indicates anatomists employed them before that date. He said this forceps:

> ... should be held in the left hand, as one holds a pen with the thumb on one branch inferiorly and the index and middle fingers on the other ... its use is to elevate fine and delicate parts for dissection which greatly promotes tidy work *(29)*.

For another century dissecting forceps retained this minor role, subservient to single and double hooks in the anatomical theatre. The detailed dissecting instrumentation illustrated by Perret in 1772 *(24)* and Savigny in 1798 *(25)*, figured several varieties of hook, but only one spring forceps; no operative surgical role was evident. By 1832, Velpeau figured a range of dissecting or tissue forceps for amputation, eye and cleft palate operations, and also modifications for arterial torsion and ligature *(30)*. In 1837, unequivocal use of surgical dissecting forceps in the left hand was illustrated by Bourgery and Jacobs *(31)*. Dissecting forceps, now common in anatomical theatres, gradually extended to surgical theatres, later responding briskly to antiseptic and aseptic techniques. Twentieth-century surgeons, faced with dissection or suturing, grasp dissecting forceps reflexly in their left hand, mostly unaware of its short existence yet long evolutionary lineage.

### Shears and scissors

Today, the application of garden or craftsmen's shears, controlled by the large radius of the spring in the hoop, appear clumsy in comparison with the precision of true scissors blades guided by a discrete and stable pivot. This explains the shears absence from surgical practice, other than hair trimming for craniotomy. Albucasis is considered to have illustrated scissors but not shears, and Spink and Lewis *(32)* suggested scissors for surgical purposes were attributable to Arab physicians of about AD 1000; the earliest pair in a museum, known to the author, are dated *c.* 1320 *(33)*.

Nevertheless, spring forceps action has been applied to motivate scissors, on a minor scale, especially for iris scissors (Fig. 6*F*) final control being determined by the pivot joint. In the case of Liebreich's and Castroviejo's scissors, the hoop is divided and one limb slots into the other *(34,35)*, forming a take-off joint.

### Endoscopic spring forceps

Late nineteenth-century experience with elongated spring forceps controlled by a sliding tube, for laryngeal grasping extractions, paved the way to their use in rigid cystoscopes, bronchoscopes, gastroscopes and later arthroscopes. In recent years the emergence of flexible fibreoptic systems has extended endoscopic approaches and minimally invasive surgery dramatically, to which the elongated spring forceps continues to contribute.

## Surgical hooks and hand-held retractors

From the late Old Stone Age, reindeer antlers or suitable forked branches shaped as trenching implements, to extract vegetable roots and flint from bedrock, represent examples of early hooked tools. Fish hooks and harpoons fashioned from bone, and later the shepherd's wooden crook also emphasise this principle. The advent of metal widened the hook's exploitation, to include the pot hook for vessels over an open fire, the mattock and the hoe, and more efficient fish hooks and harpoons.

However, mankind's concept of surgical hooking and retracting doubtless lies in the application of flexed fingers to expose tissues for the purpose of butchering meat. In early historic times, hooked fingers were employed to explore wounds for foreign bodies and, by the Renaissance, anatomical and surgical dissection depended predominantly on hooked fingers acting as retractors; even today, this digital function persists, albeit in rubber gloves.

Hooked instruments are manufactured from straight metallic rods bent near one extremity, or both, and thus relate to the primary construction of spring forceps formed by bending rods at their centre. For an effective surgical hook, the terminal bend turns through at least 135° and sometimes more than 180°, in effect producing a C-shaped extremity (Fig. 7*A–G*); however, specialised auricular and ocular hooks may have bends of less than 135° *(36)*. Hooks are both sharp and blunt.

## Sharp hooks

Most sharp hooks secure specific tissues or organs accurately with minimal trauma, for dissection, excision, eye operations or to pinpoint a bleeding vessel for ligation; from the nineteenth century, vessels were isolated with a wide radius hook, known as a tenaculum (Latin, a holder) (Fig. 7*E*). Bell wrote in 1807:

> The tenaculum is put into the surgeon's hand during an operation, with the ligature hanging on it . . . He catches the artery, and pulls it out, and the ligature is brought down towards the vessel by the assistant, and tied *(37)*.

Bell recommended that, to help surgeons working alone, the tenaculum's curve should be a full half-circle with a heavy handle to retract the artery by gravity.

Hook dimensions vary widely (Fig. 7), fine, delicate ocular and plastic surgical examples contrasting with heavy yet nonetheless sharp hooks of osseous surgery. Some procedures utilised a range of both sharp and blunt hook, for example tracheotomy (Fig 7*A–D*), cleft palate, aneurysmal and vaginal fistula repairs.

Authenticated Roman instruments include numerous single hooks, mostly sharp. Paul described tonsillectomy in the seventh century AD thus:

> . . . while one assistant holds his head, and another presses down the tongue to the lower jaw with a tongue spatula, we take a hook and perforate the tonsil with it, and drag it outwards as much as we can without drawing its membranes along with it; and then we cut it out by the root with the scalpel . . . *(38)*.

About AD 1000, Albucasis provided numerous drawings of hooks with accompanying text *(39)*. Single-, double- and treble-ended hooks, each in three sizes are noted, some sharp and some blunt, for circumcision, tracheotomy, haemorrhoidectomy and catching warts; heavy gauge hooks were advised for fetal extraction and a strong triangular pointed hook for dental extraction *(40)*. Vesalius's illustration of dissecting instruments in 1543 showed only two double sharp hooks; single hooks remained uncommon for dissection until the later eighteenth century, but predominated in late nineteenth- and twentieth-century kits, often chained together in groups of three (Fig. 7*F*). In modern times, hand retractors with blades divided into six sharp hooks have been employed *(41)*.

From the seventeenth century, a powerful crotchet was commonly used for fetal extraction; the crotchet consisted of a strong, broad, acutely angled terminal hook, either sharp or blunt.

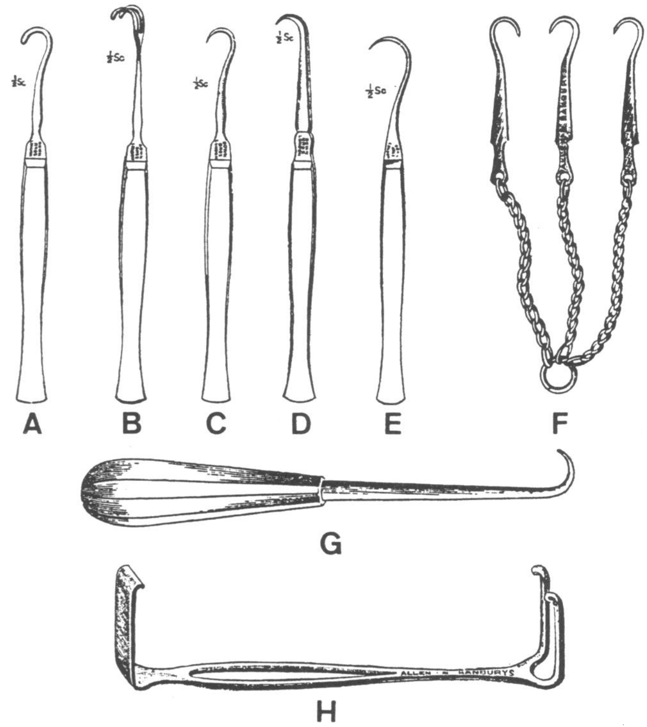


*Figure 7. A,B,C,D,* Tracheotomy hooks, single blunt, double blunt, single sharp and single sharp with grooved back. *E,* Arterial tenaculum. *F,* Dissecting chain hooks. *G,* Bone hook (Down Bros. *Surgical Instruments* . . ., 1952). *H,* Retractor, double-ended, Mathieu's (Allen & Hanbury, *Catalogue of Surgical Instruments* . . ., *c.* 1910).

### *Blunt hooks*

In general, blunt hook terminations should be of equal diameter or less than its shank for, if greater, the instrument develops the structural shape of a retractor. In reality the blunt hook, like its sharp cousin, functions as a retractor, although physically they present a clearly recognisable hook-like appearance, proving less of a C-shape with blunt rather than sharp hooks.

Blunt hooks are employed to retract skin or wound edges, but are indicated specifically for deep retraction where a sharp hook might prove dangerous. Blunt hooks are mandatory for the dissection, isolation and control of major nerves and blood vessels, in order to diminish traumatic risks. Albucasis described the use of triple blunt hooks for lifting the eyelid, in effect as a retractor *(42)*. Large single blunt hooks are associated with obstetric procedures and osseous surgery.

## Hand-held retractors

These instruments are characterised by wide extremities often of angular profile circumscribing one and often two right angles, the second angle may be less than 90° and little more than a shallow shelf (Fig. 7*H*). Excluding the sharp multi-hooked retractors mentioned above, typical retractors are blunt, often being employed with powerful force dependent on the stamina of the surgeon's assistant, especially before the introduction of muscle-relaxant anaesthesia. For abdominal surgery, blades are frequently 4–6 cm wide and 7–9 cm deep, thus distributing the pull widely and improving vision. In the case of Kelly's largest kidney retractor the blade is 6 cm wide and 18 cm deep.

### Self-retaining retractors

This classification includes those retractors controlled by a frame (Fig. 8) and excludes retractors controlled by screw hinges with additional closing racks or ratchets. The latter are classified as pivoting forceps and form a separate topic with other inset-pivot controlled instruments.

Square and ring frame controlled retractors, know as autostatic (Fig. 8*A–C*), were developed especially for suprapubic bladder and gynaecological procedures deep in the pelvis, and later applied to abdominal surgery generally. Unknown before thermal sterilisation techniques enabled the peritoneal cavity to be explored safely, they prospered in the early twentieth century.

Bivalve vaginal specula with one valve sliding on a central bar, for example Jackson's of 1889 *(43)*, may have been the stimulus for Doyen's self-retaining retractor, *c.* 1895; this utilised a single wide blade for suprapubic retraction on which sliding bars engaged externally on both thighs held in the Trendelenburg position *(44)*. It is probable that this fixation was uncertain if not dangerous to skin and deeper tissues. For appendicectomy, Gosset introduced a square bar with two blades, one fixed and the other sliding on the bar as required (Fig. 8*A*). This was adapted for other purposes and soon three-sided frames appeared utilising two or more blades (Fig. 8*B*). If the principal bar was of circular section, two parallel bars were necessary to ensure stability *(45)*. These self-retaining instruments engaged the wound margins to resist wound closing tension against their blades. The wider these spread, the tighter the retraction, and the greater the possibility of local ischaemia. If blades were deeply engaged then vital organs were endangered. Perhaps for these reasons blades were often fenestrated, constructed of a heavy wire gauge outline or of a series of blunt hooks. In 1903, McCormac introduced a square frame adjustable on all four sides for abdominal retraction *(46)*. Meanwhile these autostatic forms competed with pivot-based and rack-controlled retractors which in practice were applied more rapidly and efficiently. Nonetheless, by the mid-twentieth century a wide range of two-, three- and four-bladed retractors controlled by square and circular frames was available.

For limb fracture exposure, Pratt and Lowman introduced an almost circular retractor, made of two intersliding flat springs which encircled the limb externally but whose hooked extremities engaged the wound margins (Fig. 8*D*), and Hey Groves developed a sickle-ended retractor placed behind long bones and immobilised by a separate bar which screwed into the 'sickle' against the tension of adjacent soft tissues (Fig. 8*E*).

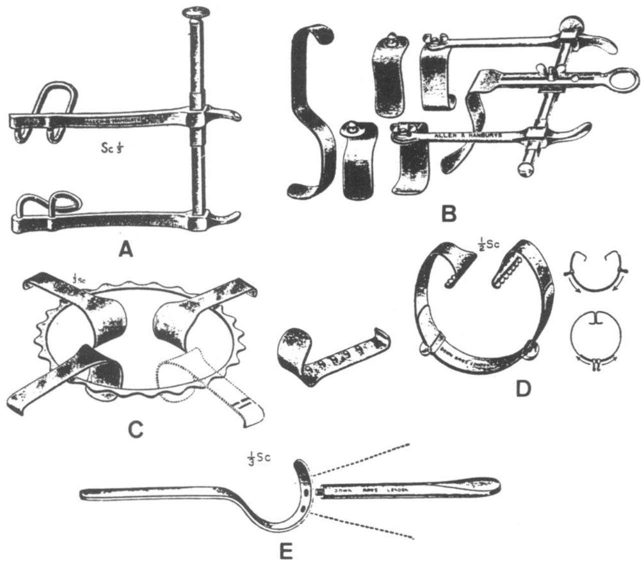


*Figure 8. A,* Appendicectomy self-retaining retractor, Gosset's. *B,* Bladder self-retaining retractor, Thompson Walker's (Allen & Hanbury, *Abridged Catalogue of Surgical Instruments . . .,* 1925). *C,* Abdominal self-retaining retractor, Browne's. *D,* Circumferential limb self-retaining retractor, Pratt Lowman's. *E,* Open fracture self-retaining retractor, Hey Grove's (Down Bros. *Surgical Instruments . . .,* 1952).

I am indebted to the President and Council of the College for their permission to mount an associated exhibition entitled 'Spring Forceps and Related Instruments' utilising the Historical Instrument Collection. I thank Ian Lyle and his staff in the College Library for their invaluable help with documentation, and I acknowledge the enthusiasm and expertise of Martyn Cooke of the Conservation Unit who arranged the exhibition so meticulously.

## References

*1* Liston R. *Practical Surgery*. London: Churchill, 1837: 20.
*2* Darwin C. *The Descent of Man and Selection in Relation to Sex*, 2nd Edition. London: Murray, 1874: 50.
*3* Møller-Christensen V. *The History of the Forceps*. Copenhagen: Levin & Munksgaard, 1938: i.
*4* Kirkup J. The ancient lineage but short life of the dissecting forceps. *European Rheumatoid Arthritis Surgical Society Information Bulletin* 1994; **8**: 7–11.
*5* McFadden JT. The origin and evolutionary principles of spring forceps. *Surg Gynecol Obstet* 1970; **130**: 356–68.
*6* Kirkup PA. Personal communication.
*7* Down Brothers. *Surgical Instruments Appliances and Hospital Equipment*. London, 1952: 123.
*8* Møller-Christensen V. *The History of the Forceps*. Copenhagen: Levin & Munksgaard, 1938: 10.
*9* Møller-Christensen V. *The History of the Forceps*. Copenhagen: Levin & Munskgaard, 1938: 66–75.
*10* Adams F. *The Genuine Works of Hippocrates*. London: Sydenham Society, 1849.

11 Kirkup JR. Historical Study of the Surgical Armamentarium. Thesis, Cambridge University, 1994: 65.
12 Spink MS, Lewis GL. *Albucasis on Surgery and Instruments*. London: Wellcome Institute, 1973: 190.
13 Møller-Christensen V. *The History of the Forceps*. Copenhagen: Levin & Munksgaard, 1938: 170–80.
14 Ryff W. *Grosse Chirurgia, oder Vollkommene Wundarznei*. Frankfurt: Egonolph, 1545. Croce JA. *Chirurgiae Libri Septem*. Venice: Zilettum, 1573. Paré A. *Les Oeuvres*. Paris: Buon, 1575. Guillemeau J. *La Chirurgie Francoise*. Paris: Gilles, 1594.
15 Kirkup JR. Historical Study of the Surgical Armamentarium. Thesis. Cambridge University, 1994: Table IV.
16 Møller-Christensen V. *The History of the Forceps*. Copenhagen: Levin & Munksgaard, 1938: 184.
17 Charrière J. *Notices sur les Instruments et Appareils de Chirurgie*. Paris: author, 1855: 32.
18 Møller-Christensen V. *The History of the Forceps*. Copenhagen: Levin & Munksgaard, 1938: 274–7.
19 Down Brothers. *A Catalogue of Surgical Instruments and Appliances*. London, 1897: 573.
20 Bourgery JM, Jacob NH. *Traité Complet de l'Anatomie de l'Homme Comprenant la Médecine Opératoire*, Vol. VI. Paris: Delaunay, 1837: Pl. 34, Fig. 1.
21 Allen & Hanbury Ltd. *A Reference List of Surgical Instruments*. London, 1930: 248.
22 Milne JS. *Surgical Instruments in Greek and Roman Times*. London: Clarendon Press, 1907: 49–50.
23 Scultetus J. *Armamentarium Chirurgicum*. Ulm: Kuhnen, 1655: Pl. 34, Fig. 8.
24 Perret J-J. *L'art du Coutelier Expert en Instruments de Chirurgie*. Paris, 1772: Pl. 81, Fig. 32.
25 Savigny J. *A Collection of Engravings Representing the Most Modern and Approved Instruments used in the Practice of Surgery*. London: Bensley, 1798: Pl. 9, Fig. 10.
26 Bourgery JM, Jacob NH. *Traité Complet de l'Anatomie de l'Homme Comprenant la Médicine Opératoire*. Vol. VI. Paris: Delaunay, 1837: 75.
27 Liston R. *Practical Surgery*. 2nd Edition. London: Churchill, 1838: 20–22.
28 Vesalius A. *De Humani Corporis Fabrica Libri Septem*. Basle: Oporinus, 1543: ch. 41.
29 Garengeot R. *Des Instruments de Chirurgie les Plus Utiles*. Vol. I. Paris, 1725: 112.
30 Velpeau AALM. *Nouveaux Éléments de Médecine Opératoire*. Atlas. Paris: Baillière, 1832.
31 Bourgery JM, Jacob NH. *Traité Complet de l'Anatomie de l'Homme Comprenant la Médecine Opératoire*. Vol VI. Paris: Delaunay, 1837, Pl. 15, Fig. 6.
32 Spink MS, Lewis GL. *Albucasis on Surgery and Instruments*. London: Wellcome Institute, 1973: 398.
33 Smith IF. *Windmill Hill and Avebury*. Oxford: Clarendon Press, 1965: 92.
34 Down Brothers. *Surgical Instruments Appliances and Hospital Equipment*. London: 1952: 979.
35 Stille. *Surgical Instruments (a catalogue)*. Stockholm, 1982: 102/9.
36 Down Brothers. *A Catalogue of Surgical Instruments and Appliances*. London, 1906: 140, 165.
37 Bell C. *A System of Operative Surgery*. Vol 1. London: Longman, 1807: 52–3.
38 Adams F. *The Seven Books of Paulus Aegineta*. Vol. II. London: Sydenham Society, 1846: 297.
39 Spink MS, Lewis GL. *Albucasis on Surgery and Instruments*. London: Wellcome Institute, 1973: 350–55.
40 Spink MS, Lewis GL. *Albucasis on Surgery and Instruments*. London: Wellcome Institute, 1973: 284.
41 Mayer & Phelps. *An Illustrated Catalogue of Surgical Instruments and Appliances*. London, 1931: 24.
42 Spink MS, Lewis GL. *Albucasis on Surgery and Instruments*. London: Wellcome Institute, 1973: 212–15.
43 Down Brothers. *A Catalogue of Surgical Instruments and Appliances*. London: 1889: 283.
44 Arnold & Sons. *Catalogue of Surgical Instruments and Appliances*. London, 1904: 690.
45 Arnold & Sons. *Catalogue of Surgical Instruments and Appliances*. London, 1904: 188.
46 MacCormac JS. Exhibit, British Gynaecological Society Meeting, 12 March 1903. *Br Gynaecol J* 1903; **19**: 32–3.

*Received 17 April 1996*